

Asphalt Rubber Research Projects

Arizona State University

PCCAS

December 11, 2001



ADOT – ASU Research Program

- Five Year Work Plan
- AC Binder Database
- AC Mixture Tests: Stiffness, Fracture, Deformation
- Implementation of Simple Performance Tests
- Unbound Materials
- Implementation of EICM to Arizona
- 2002 Design Guide: Calibration – Validation to ADOT
- Development of ADOT Performance Related Specifications

Main Objectives of AR Research

- ⇒ Obtain Typical Engineering Material Properties for AR Mixtures
- ⇒ Compare the Performance of AR Mixtures To Conventional ADOT Mixtures
- ⇒ Study Effects
 - Aging
 - Field - Laboratory Compaction

ASPHALT-RUBBER PROJECT MAP
PREPARED BY ARIZONA DEPARTMENT OF HIGHWAYS
DECEMBER 1998



Buffalo
Range
I-40 MP 229

AR Research Projects

➲ I-40 Buffalo Range

- ➲ One Stock Binder (58-22).
- ➲ Gap / Open Graded Mixes.
- ➲ Binder Tests.
- ➲ Mixture Tests on HMA.
 - In-situ Air Voids
 - 2 Temp



Ends March 2002.

6210:

AR Demonstration Program

Ford Motor Company

- ➡ Ford Acting as a Catalyst to Expand the Environmental Responsible Use of Crumb Rubber
- ➡ Demonstrate the Use of Ground Tire Rubber in Asphalt Pavement Construction
 - >> Nationwide Implementation.



AR Demonstration Program

- ⇒ I-17 Frontage Road
- ⇒ Mainly PG 64-16 / (Test Section 58-22).
- ⇒ Gap Graded Mix
- ⇒ Collected Binder and HMA
- ⇒ Laboratory Experimental Design on HMA
 - 3 Compaction Levels, 2 Test Temperatures
 - 2 Aging Levels
 - Field Specimens at Different Aging Periods
- ⇒ Reflective Cracking Model Verification
- ⇒ 24 mo (Completed Nov 2003).



Satisfy Research Needs

- ➲ Project 2: PG Binder Specifications for AR Binders.
- ➲ Project 8: Database of Asphalt Rubber Projects.
- ➲ Project 10: Evaluate AR Using 2002 Design Guide Test Protocols.
- ➲ Project 11: Laboratory and Field Evaluation

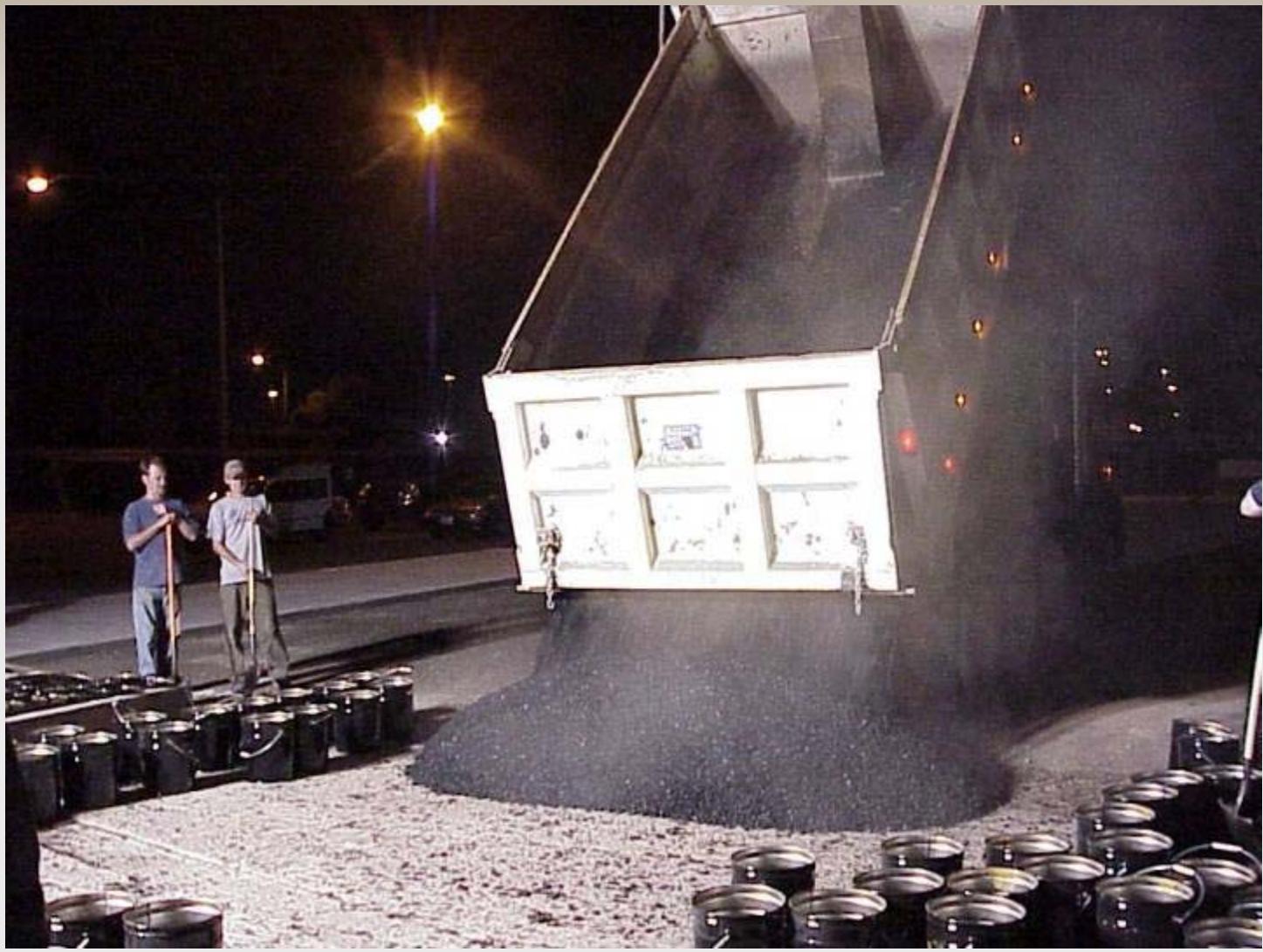










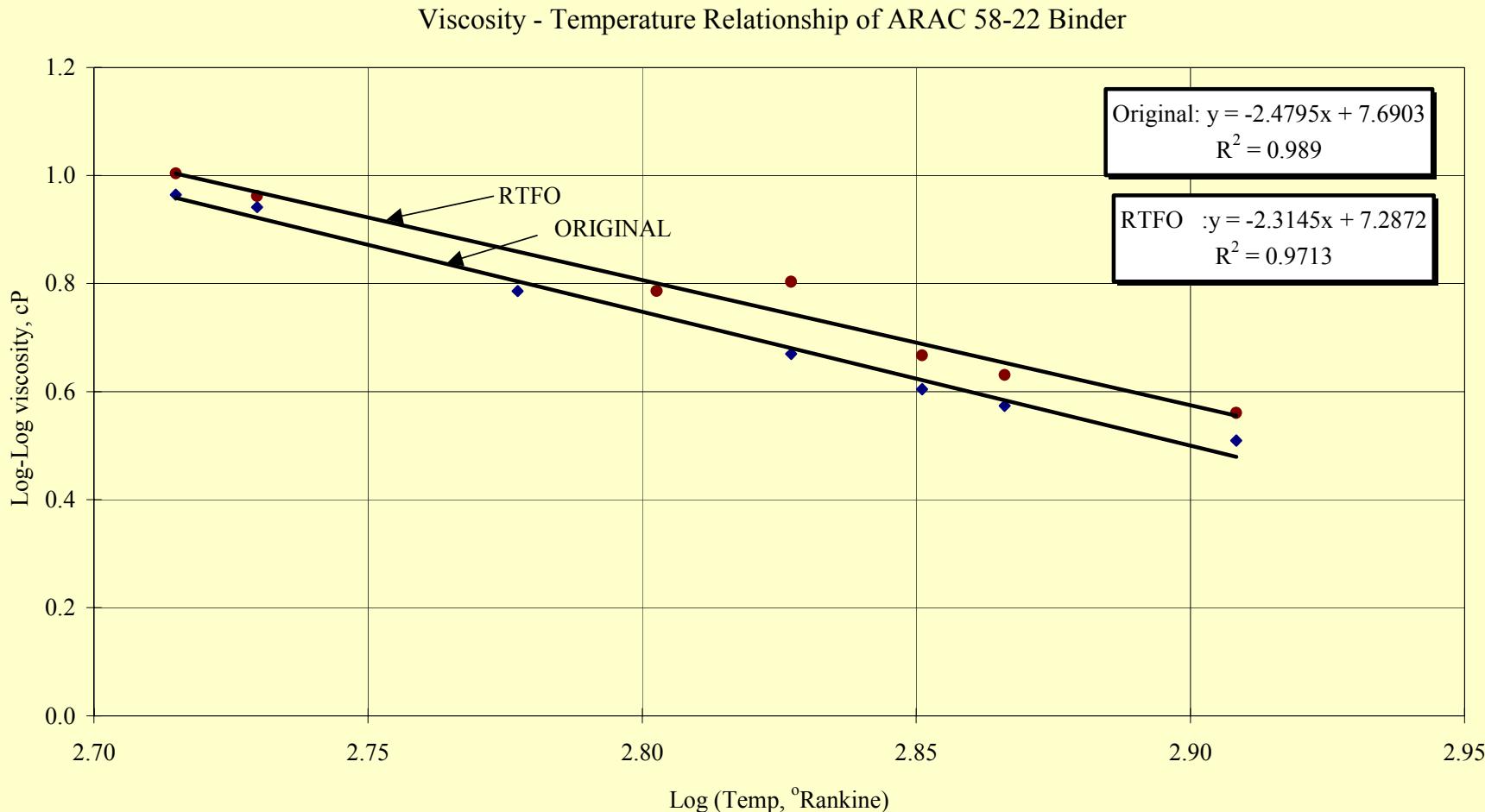




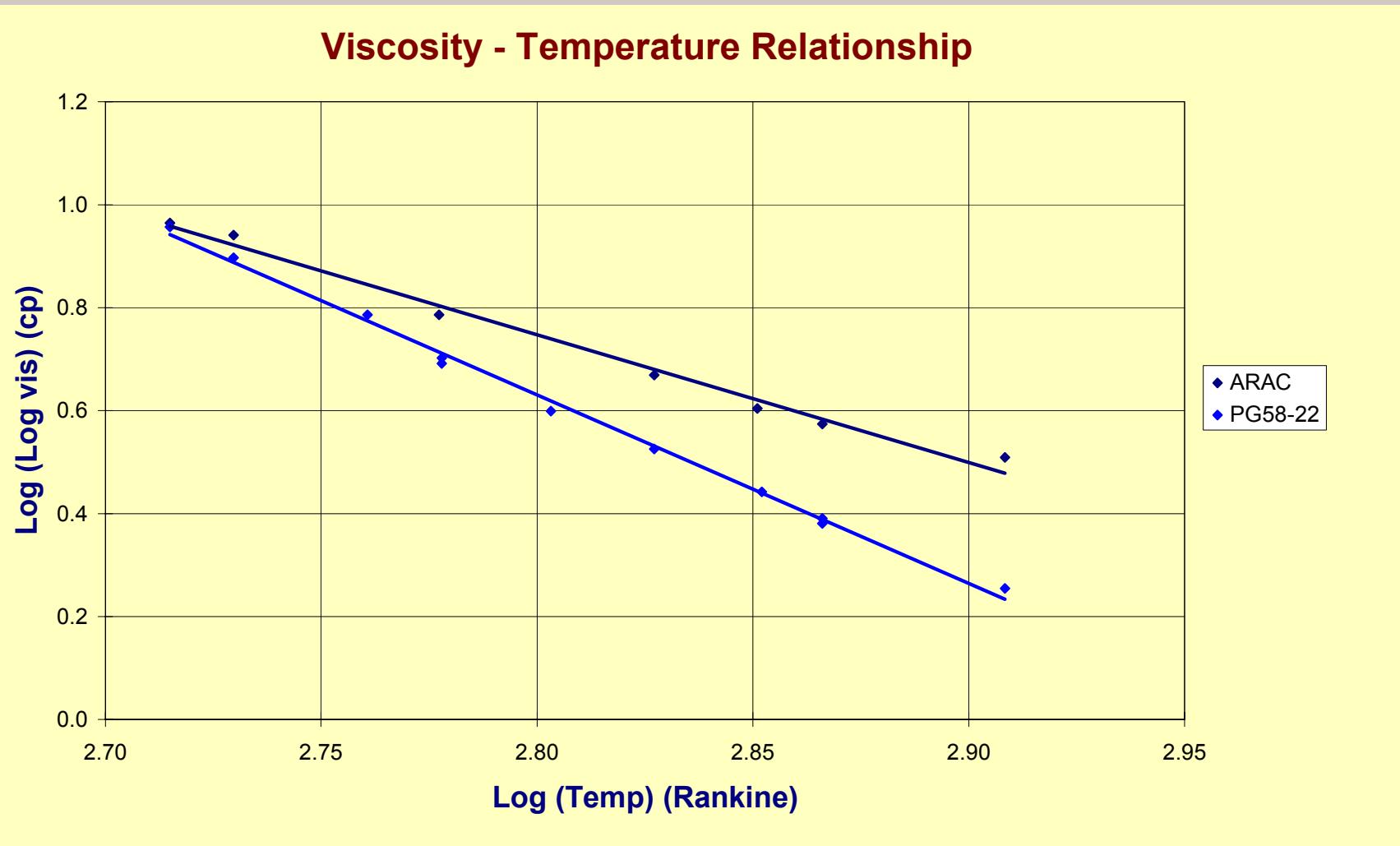


Binder Tests

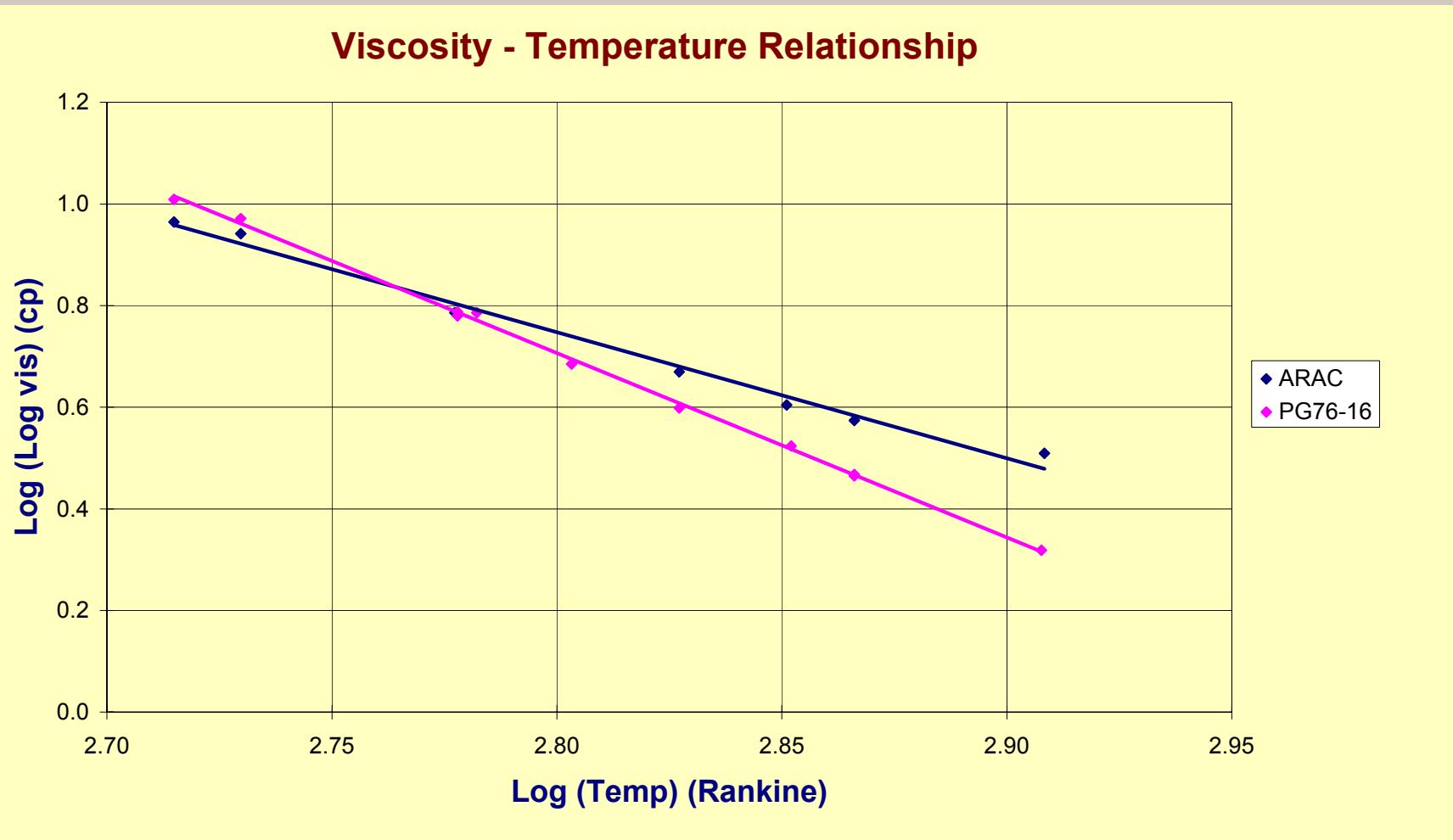
Original – RTFO



ARAC (PG58-22 + R)



Comparison of ADOT Binders



Specimen Preparation



Mixture Tests

Permanent Deformation

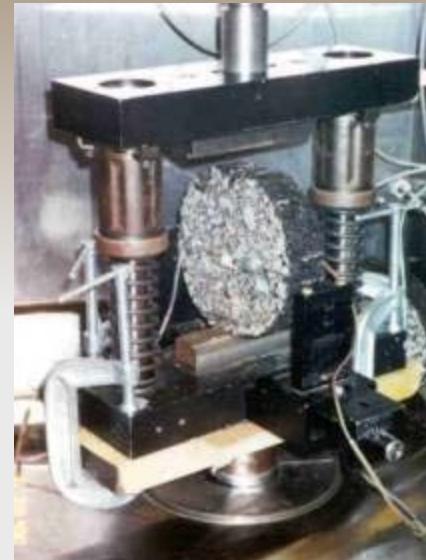
Triaxial Compression – High Temperatures

1. Dynamic Modulus
2. Static Creep / Flow Time Test
3. Repeated Load Permanent Deformation Test

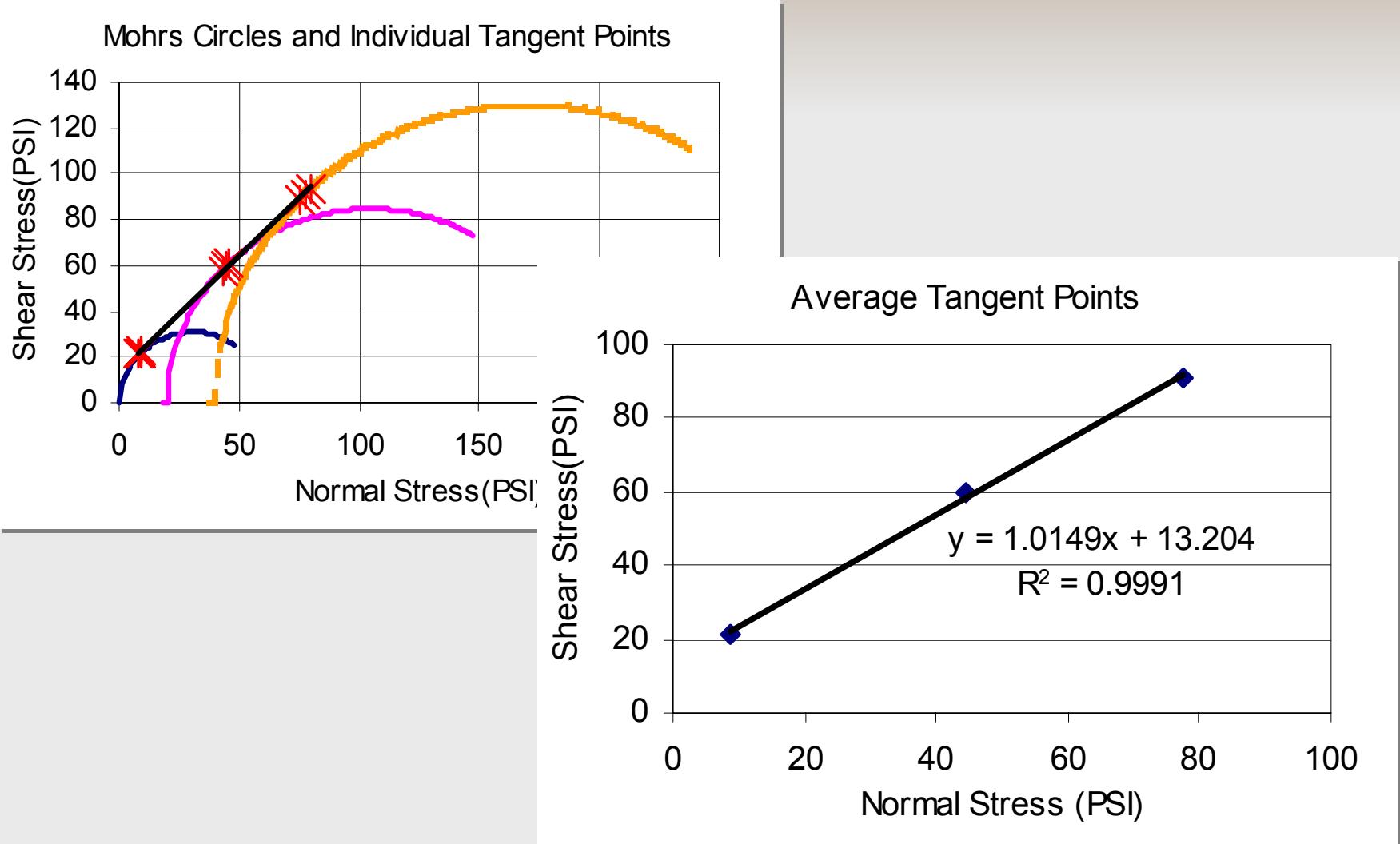


Cracking

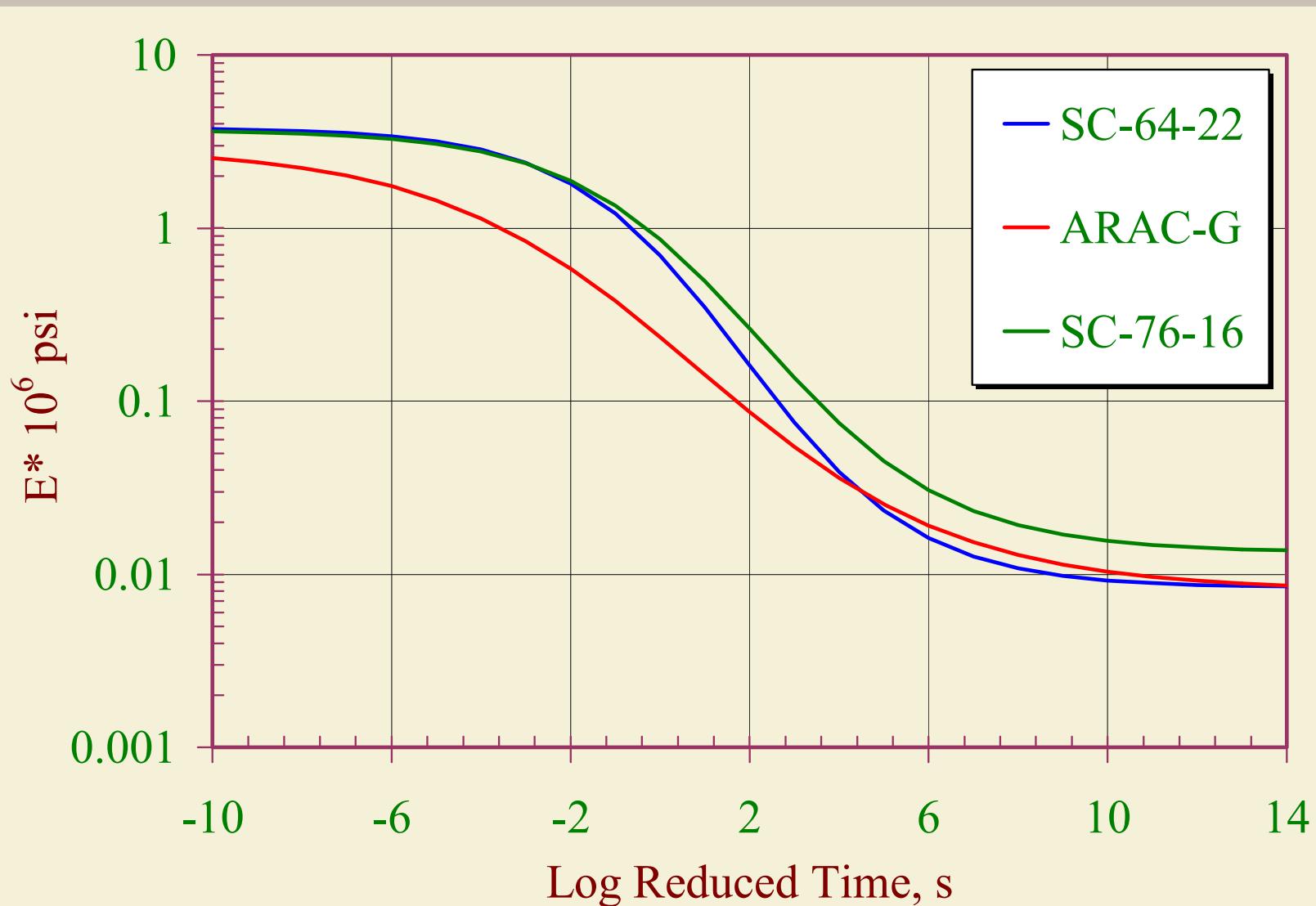
1. Dynamic Modulus (low temp)
2. Indirect Tensile Creep Test
 - Creep Compliance
 - Strength
3. Beam Fatigue Tests
 - SHRP M-009



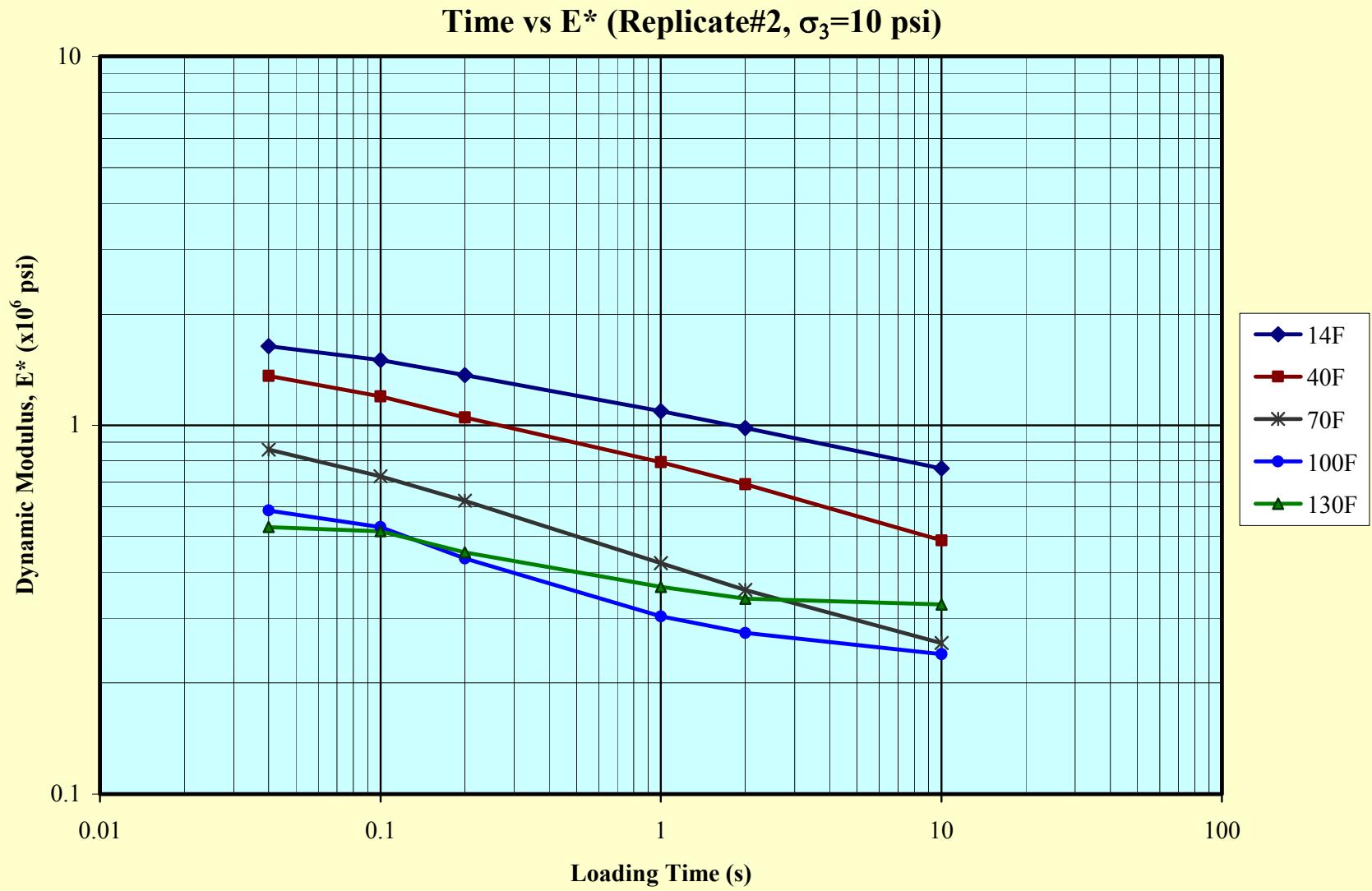
Triaxial Shear Strength – ARAC 100°F



E^* Master Curve

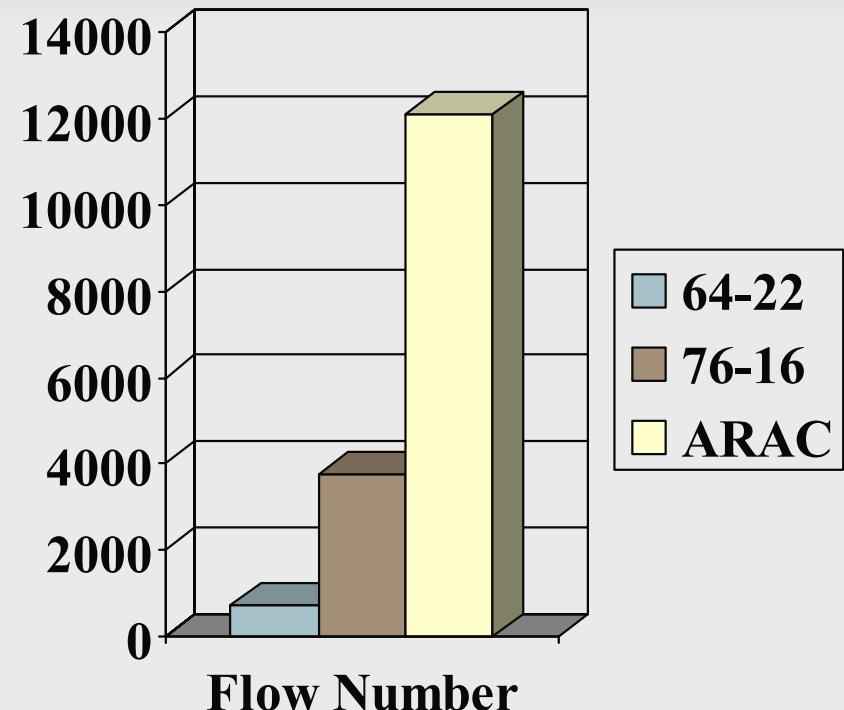
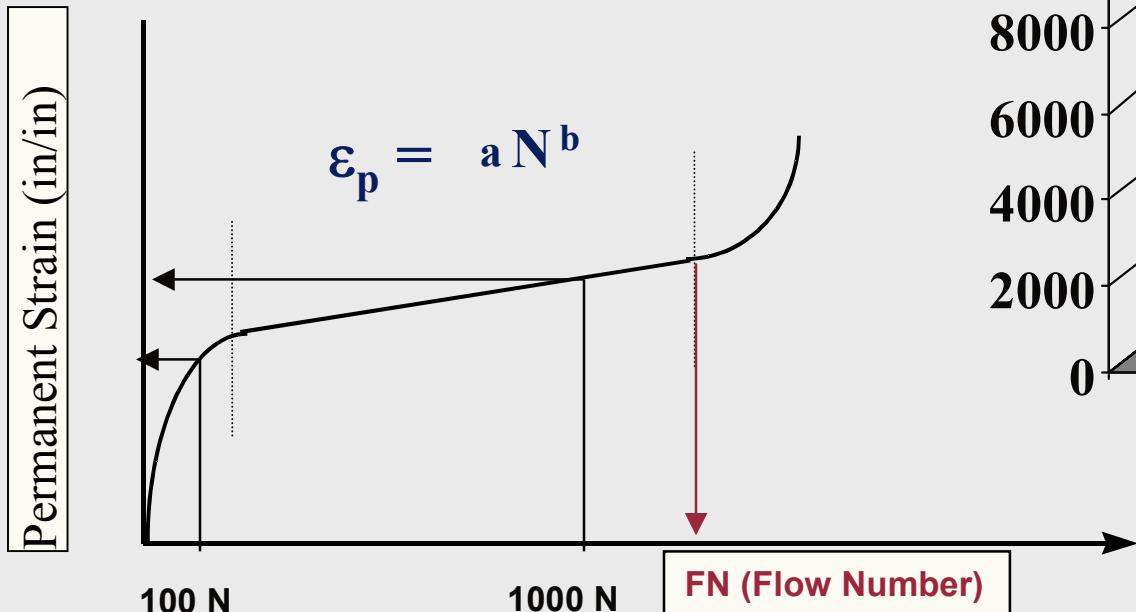


E^* Confined Tests



Repeated Load Test

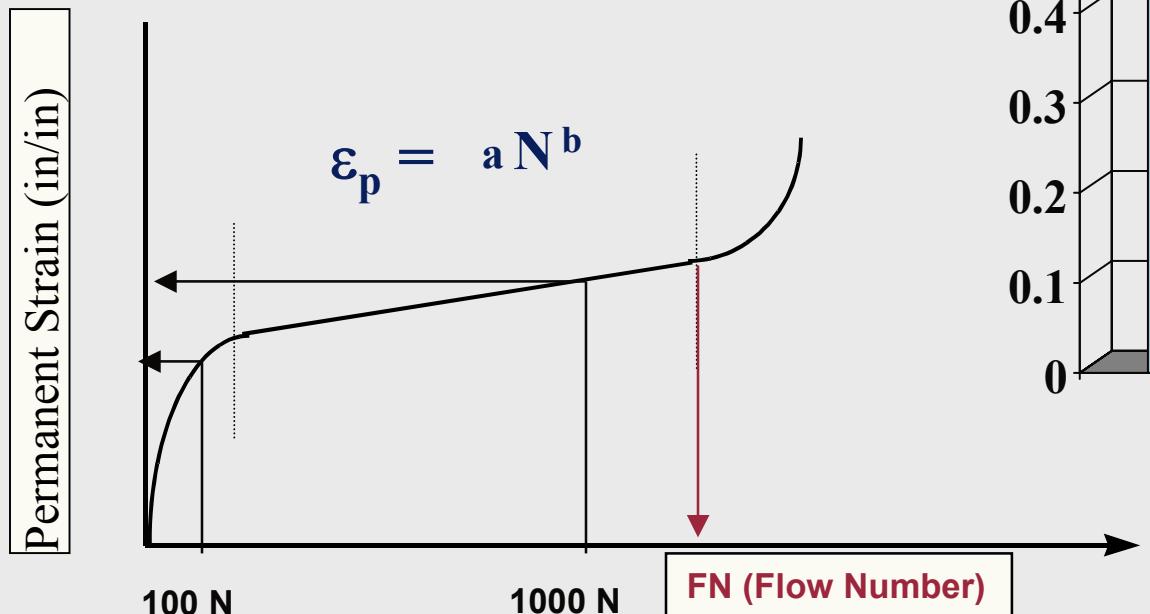
- 130°F
- $\sigma_1=10$ psi, Unconfined



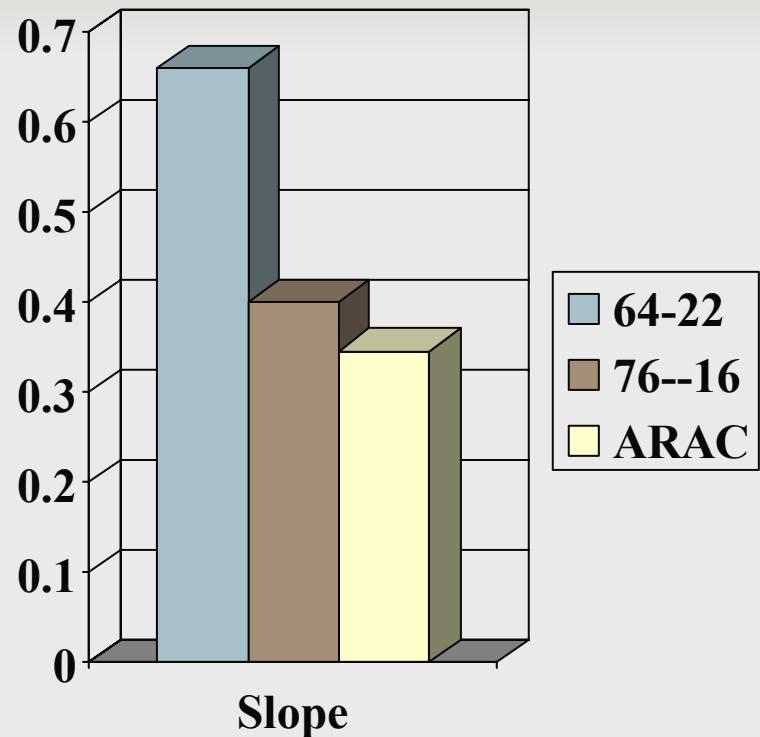
Loading Cycles

Repeated Load Test

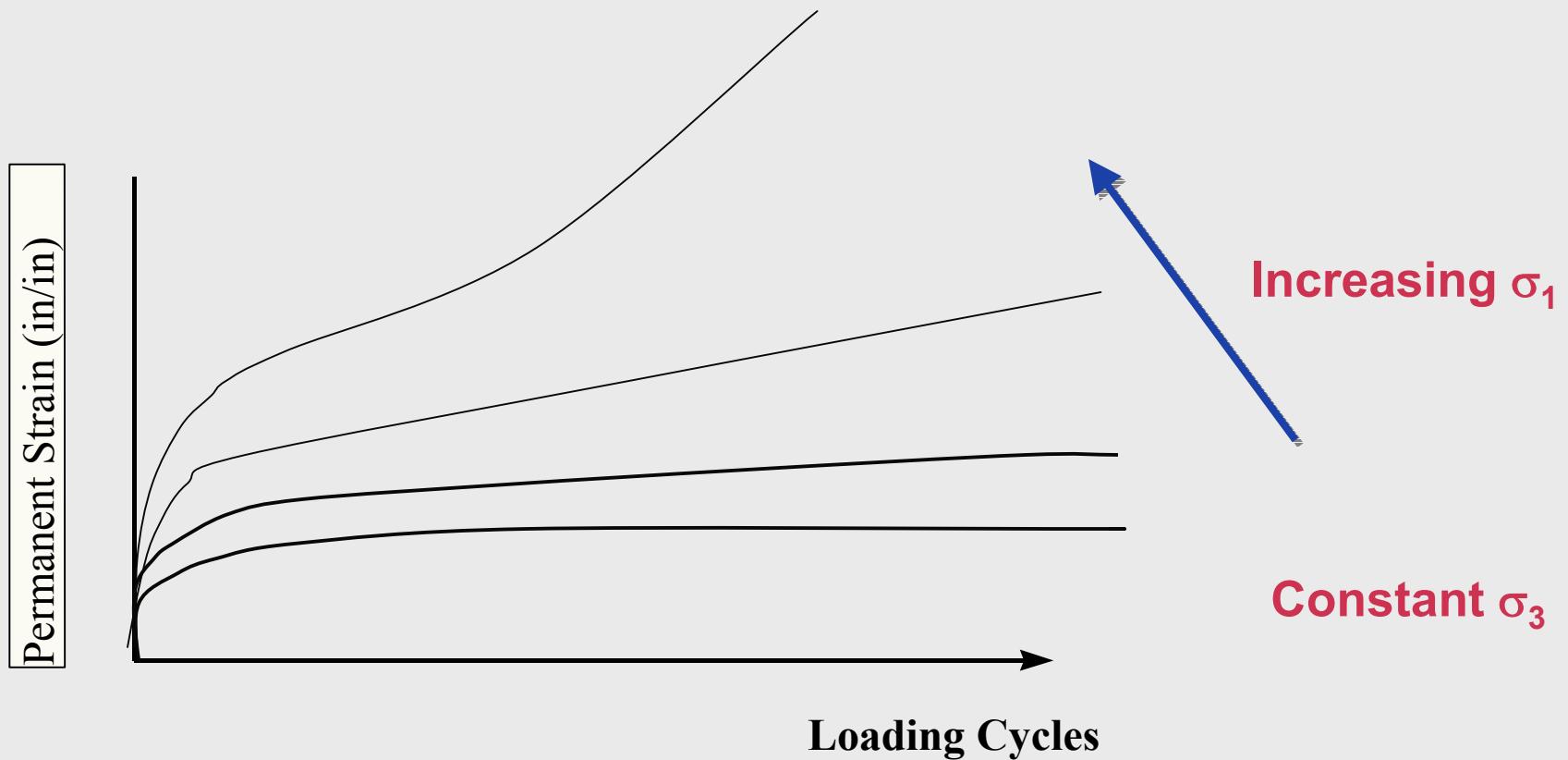
- 130°F
- $\sigma_1=10$ psi, Unconfined



Loading Cycles



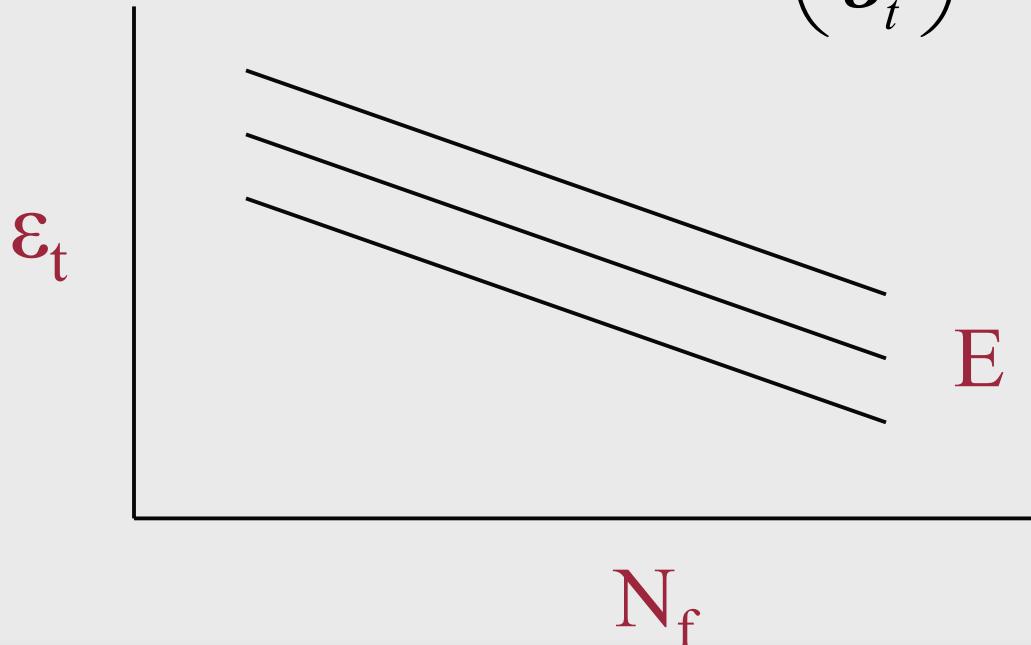
Confined Repeated Load Tests



Fatigue Tests

Generalized fatigue equation for mixed loading mode:

$$N_f = K_1 \left(\frac{1}{\varepsilon_t} \right)^{k_2} \left(\frac{1}{E} \right)^{k_3}$$



Test Results

Fatigue Relationship for ADOT Rubber Asphalt Gap

Graded Mix, Control Strain, at 50% of Initial Stiffness

$$N_f(100) = 3E17 \varepsilon^{-4.0352}$$

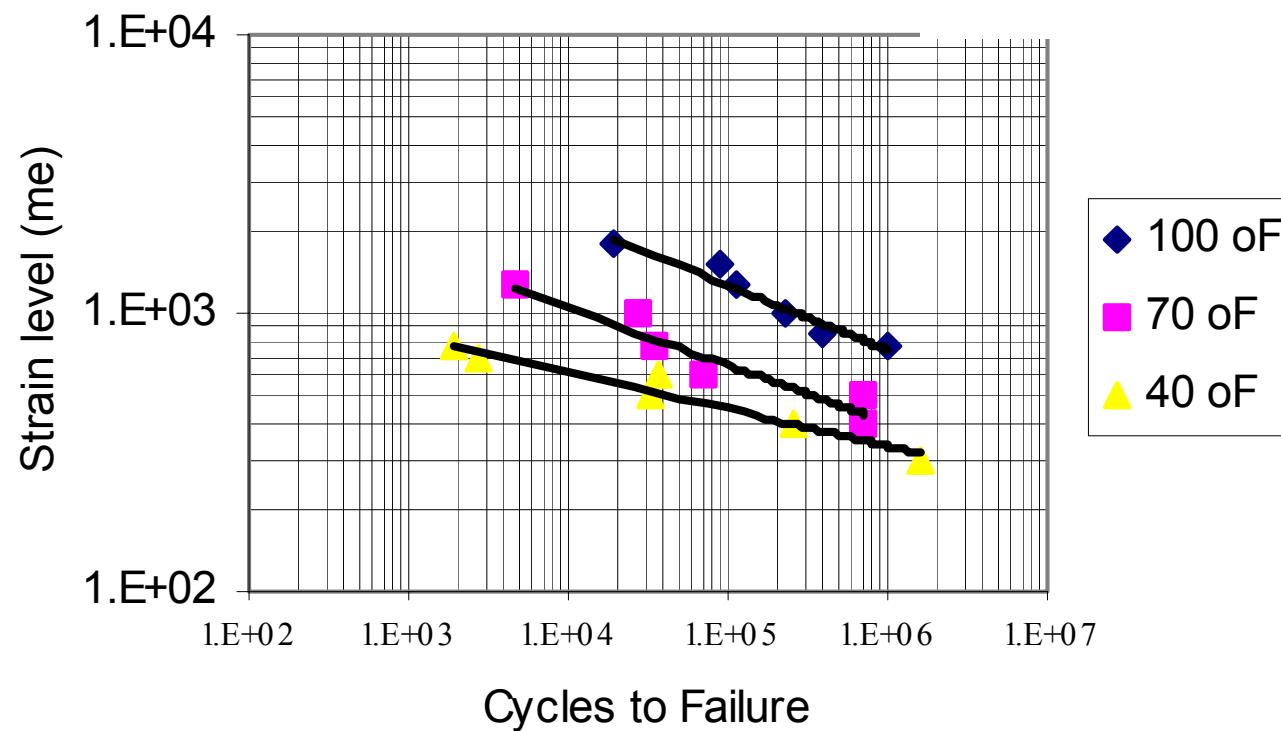
$$R^2 = 0.9412$$

$$N_f(70) = 7E+15 \varepsilon^{-3.8993}$$

$$R^2 = 0.9448$$

$$N_f(40) = 1E24 \varepsilon^{-7.1944}$$

$$R^2 = 0.9412$$



Fatigue Parameters

Mixture	K ₁	K ₂	K ₃
76-16	.0089	4.3992	1.3368
ARAC	.0250	4.2309	1.2671

To Be Continued ...